THE NOISE OF LIGHTNING.

BY PROF. JOHN TROWBRIDGE.

Some recent experiments in the Jefferson Physical Laboratory show in a striking manner that the astounding noise of a lightning discharge is largely due to the dissociation of water vapor; moreover, the length of such discharges is greatly modified by the amount of moisture present in the clouds. This latter conclusion seems almost self-evident; but the following experiments brought out the fact with what may be truly called dazzling distinctness.

The experiments grew out of my long study of the spectrum of water vapor; and abandoning for the nonce the baffling study of the spectra of water vapor in glass and also quartz tubes, I resolved to study the spectrum produced by electrical discharges of great quantity in air saturated by moisture. In order to obtain such discharges I used a storage battery of twenty thousand cells to charge large glass condensers. I also had a transformer constructed which was excited by an alternating current of 110 volts. This transformer has several interesting features.

It consisted in the main of nineteen flat bobbins of fine wire slipped upon a laminated iron core. The bobbins are one foot across and three-quarters of an inch thick; and are separated from each other by plates of glass one-eighth of an inch thick. No insulating or otherwise protecting covering is placed upon the exposed portion of the coils. The openness of the construction permits of many methods of joining the coils for quantity or intensity; and also permits of the easy removal of any bobbin which may become defective.

The coils are slipped upon the laminated core of a closed magnetic circuit, and the electromagnets of the primary circuit of the transformer are on a portion of the magnetic circuit not embraced by the bobbins of the fine wire circuit. By this arrangement I avoided a short circuit from the secondary to the primary, and also the possible heating due to long running of the primary current. This latter point is an important one to be considered in the construction of transformers for use in spectrum analysis, where several hours of exposure are often necessary. Large wire was used in the construction of the primary coils, a method of construction due to Dr. William Rollins, of Boston. The construction of this coil is an approximation to the magnitude of transformers used in practical employments of electricity. I am firmly convinced that physicists must enlarge their experimental appliances in order to study electro-dissociation. It would be even desirable to put at the disposal of the investigator in spectrum analysis transformers of the magnitude employed by the Niagara Construction Company. The transformer I have described was excited by six amperes, and gave a spark of great body of two inches when Leyden jars were used. Fig. 1 is a photograph of the transformer one-fourteenth natural size.

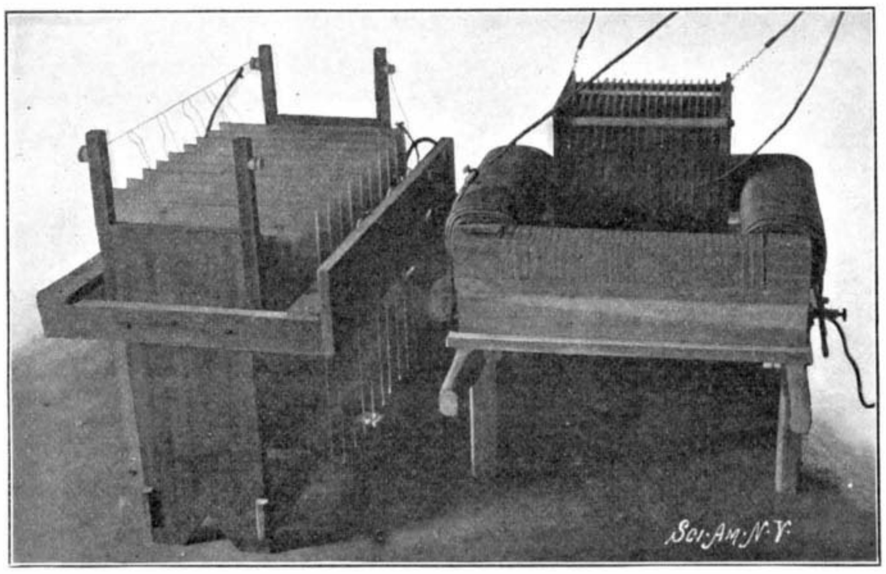


Fig. 1.—The Transformer.

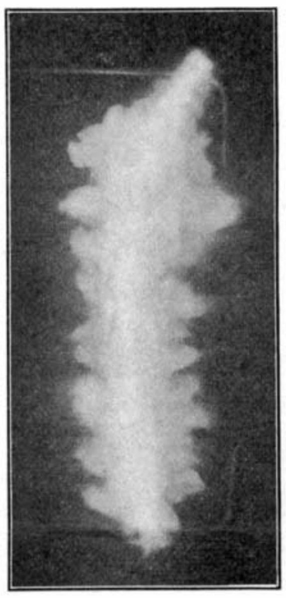


Fig. 2.—The Electric Discharge Between Water Terminals.

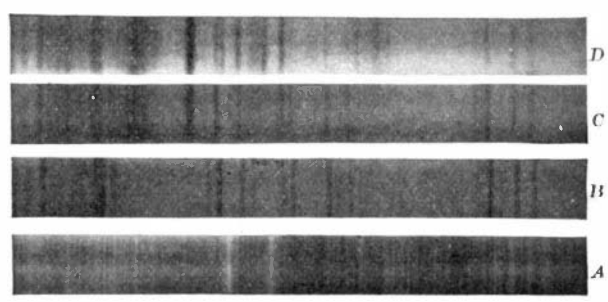


Fig. 3.—Spectrum of Water Vapor at Atmospheric Pressure, Together With Other Atmospheric Lines.

THE NOISE OF LIGHTNING.

At first sight it seems possible to study the spectrum of water vapor by causing electric sparks to pass from one surface of water to another; in other words, by employing water electrodes. It is, however, practically impossible to cause an electric spark of high electromotive force to leap from one surface of a liquid to another. For this reason it is rare that lightning strikes the surface of level water.

I therefore, having saturated two pieces of wood with distilled water, wrapped them with cotton wool which was also heavily saturated with distilled water. When such terminals were separated a distance of four inches, a torrent of extremely bright sparks leaped across the interval. The noise of the discharge was deafening, and the operator was compelled to stuff his ears with cotton, and furthermore to wrap a heavy cloth around the ears. The striking distance of the sparks was increased by the employment of the wet terminals from two inches to four. The deafening noise was probably caused by the explosion of the hydrogen and oxygen gases produced by the dissociation of the water vapor. The noise of lightning discharges is doubtless enhanced in the same manner by the presence of great moisture in the clouds. Fig. 2 is a photograph of the electric discharge between water terminals, extending over the wetted surface.

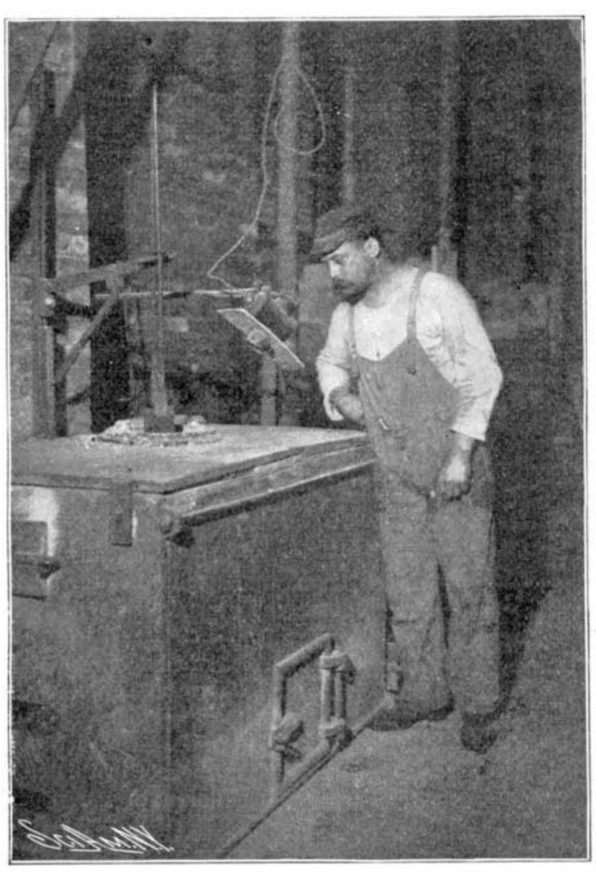
Fig. 3 shows the spectrum of water vapor at atmospheric pressure, together with other atmospheric lines. This spectrum must be regarded as the spectrum of lightning when the lightning discharge takes place in regions not more than a mile high and between clouds heavily laden with moisture. In the photograph, *A* represents the portion of the sun's spectrum near the two great *HH* lines, the strongest lines in the solar spectrum. *B* is the spectrum of water vapor with characteristic doublets; *C* and *D* are spectra of atmospheric air, showing traces of vapor.

AN OPTICAL PYROMETER.

In our various industries, accurate means are provided for determining the different properties of the various materials which enter into the construction of the finished product. Lengths are measured with the greatest accuracy by aid of delicate micrometers; weights by scales of various degrees of delicacy; densities by hydrometers; and the composition of the various materials by chemical analysis, etc.; but while the lower temperatures are read by the aid of the mercurial thermometer, in these industries, the higher temperatures seem to have been guessed at, or measured by skilled observers. The operators estimate these temperatures by the color or degree of incandescence of the materials which are being heated. There are various pyrometers on the market for measuring these temperatures. Still, in the general case, the old method seems to be resorted to.

It is well known that the value of the finished product depends in a large measure upon the accuracy with which the heat treatments have been conducted. For example, the strength of structural irons and the durability of steel rails depend largely upon the temperature at which they have passed through the rolls the last time. The cost of machining tools, as well as the quality of the finished tools, depends in a large measure upon the temperature at which the steel has been annealed, and the keenness which can be given to the edge of tools, and also the length of time the tool can retain its sharpness, depends altogether upon the temperature at which it is hardened and tempered.

In many steels, the range of temperature at which



Determining the Temperature of Heated Parts.

The Thermo-Gage.

Measuring the Temperature of a Hardening Furnace.

AN OPTICAL PYROMETER.